Patent Claims

1. A method for producing boreholes with a large aspect ratio, in metallic materials, layered metallic materials and materials comprising at least one ceramic layer, by means of laser radiation, the intensity of the laser beam being adjusted according to the required modification of the borehole radius in relation to the borehole depth, characterized in that the spatial distribution of the intensity of the laser beam, in relation to the changing bottom of the borehole, is adjusted in such a way that the intensity I inside the segment w_0 at a distance w from the laser beam axis falls by the value ΔI, said drop occurs monotonously, and values are set for the spatial modification ΔI of the intensity I and for the segment w_0 that are so high that a borehole radius r_B ($r_B > w_0$) is larger than the segment w_0, the segment w_0 being the radius of the laser beam.

2. The method according to claim 1, characterized in that the segment w_0 is set approximately in proportion to the root of the predefined borehole depth *l* to be achieved.

3. The method according to claim 1 or 2, characterized in that the spatial modification ΔI of intensity I is set in proportion to the predefined borehole depth *l* or the borehole depth *l* to be achieved.

4. The method according to any one of claims 1 to 3, characterized in that the maximum aspect ratio α of borehole depth *l* to borehole diameter d and the minimum diameter $d_{min} > l / \alpha$ ($d_{min} = 2r_{Bmin}$) of the borehole are set by the following rule

$\alpha <$ const. $\Delta\ w_0$,

the spatial modification $\Delta I = I_0 - Iw_0$ being intensity I within the segment w_0, and I_0 being the intensity on the laser beam axis and I_{w0} the intensity at the distance w_0 from the laser beam axis.

5. The method according to any one of claims 1 to 4, characterized in that for enlarging the borehole diameter d ($=2r_B$) during drilling the maximum value $I_0 > I_{min}$ for the intensity is controlled or regulated such that the borehole diameter d ($=2r_B$) reaches a predetermined depth-dependent

value $d > d_{min}$, I_0 being the intensity on the laser beam axis and I_{min} the minimum value of intensity I_0.

6. The method according to any one of claims 1 to 5, characterized in that for enlarging the borehole diameter d ($=2r_B$) during drilling the segment $w_0 > w_{min}$ is controlled or regulated such that the borehole diameter d ($=2r_B$) reaches a predetermined depth-dependent value $d > d_{min}$, w_0 being the radial distance from the laser beam axis and w_{min} the minimum distance from the laser beam axis over which the spatial modification ΔI takes place.

7. The method according to any one of claims 1 to 6, characterized in that when different material layers are drilled the intensity distribution of the laser radiation is adapted during transition from one layer of material to the next one in such a manner that the same or the predetermined depth-dependent borehole diameter is achieved in both material layers.

8. The method according to claim 7, characterized in that the transition between two material layers is monitored by changing the process emissions.

9. The method according to claim 8, characterized in that the change in the process emissions is detected by coaxial or lateral high-speed photography.

10. The method according to any one of claims 1 to 9, characterized in that when a set borehole diameter d ($=2r_B$) is reached the borehole wall is heated in addition.

11. The method according to claim 10, characterized in that the heating power is increased with an increasing depth of the borehole.

12. The method according to claim 10 or 11, characterized in that heating is limited to the melt flowing out of the borehole.

13. The method according to claim 12, characterized in that the heat radiation is generated through beam shaping in the resonator in such a manner that the intensity of the laser beam is annularly irradiated onto the borehole for heating the borehole wall.

14. The method according to claim 13, characterized in that the heat radiation is generated by excitation of higher

modes at least after the predetermined borehole diameter has been reached.

15. The method according to claim 13, characterized in that the heat radiation is generated by way of apertures, the central portion of the laser beam being masked.

16. The method according to claim 12, characterized in that the laser radiation is shaped by an optical component outside the resonator such that a central portion of the laser beam produces the predetermined borehole diameter and an annular outer portion of the laser beam is irradiated onto the borehole for heating the borehole wall.

17. The method according to claim 16, characterized in that an axicon is used as the optical component outside the resonator.

18. The method according to claim 12, characterized in that the heat radiation is coupled into the borehole via a second source of energy in the form of thermal energy.

19. The method according to claim 12, characterized in that the heat radiation is generated via a plurality of annularly arranged diode lasers.

20. The method according to claim 12, characterized in that the heat radiation is generated via a thermal light source.

21. The method according to claim 20, characterized in that a halogen lamp is used as the thermal light source.

22. The method according to claim 20, characterized in that an arc lamp is used as the thermal light source.

23. The method according to claim 20, characterized in that a vapor lamp is used as the thermal light source.

24. The method according to claim 12, characterized in that the heat radiation is generated via a laser beam source, the generated plasma acting as a secondary heat source on the wall of the borehole.

25. The method according to claim 24, characterized in that the same laser beam source as the one used for drilling is used for generating the heat radiation.

26. The method according to claim 13, characterized in that the control of the heat radiation is detected by coaxial or lateral high-speed photography.